


実験報告書様式(一般利用課題・成果公開利用)

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	承認日 Date of Approval 2017/10/16 承認者 Approver Takashi Ohara 提出日 Date of Report 2017/9/28
課題番号 Project No.2017A0220 実験課題名 Title of experiment Magnetic structure of a magneto-electric oxide Co ₄ Ta ₂ O ₉ 実験責任者名 Name of principal investigator Taka-hisa Arima 所属 Affiliation University of Tokyo / RIKEN	装置責任者 Name of Instrument scientist A. Nakao and 装置名 Name of Instrument/(BL No.) BL-18 実施日 Date of Experiment From 8th to 13th May 2017 and from 22nd to 24th June 2017

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)
 Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.
<p>A single crystal of Co₄Ta₂O₉ with a diameter of about 5 mm and a length of about 5 mm.</p>

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。) Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.
<p>Co₄Ta₂O₉ undergoes a magnetic transition at 20 K. It exhibits fairly large linear and non-linear magneto-electric effects in the antiferromagnetic phase. To reveal the origin of the magneto-electric effects, neutron diffraction measurements were performed on a large single crystal by using SENJU.</p> <p>First, zero-magnetic-field measurements were performed at 25 K and 4 K. 1st-frame intensity data were collected at seven orientations at each temperature. 2nd frame measurements were also carried out at 4 K. The profiles along the (00L) line are shown in Fig. 1. The crystal structure was refined by fitting the 25-K data. The magnetic structure was analyzed by using the atomic coordination. Here the presence of six types of magnetic domains were considered because the system is hexagonal. Magnetic structures of C₂/c' and C₂'/c provide similar R factors. Nonetheless, we can conclude that the Co spin moments are antiferromagnetically arranged in each honeycomb layer and ferromagnetically along the c-axis, as shown in Fig. 2. The ordered moments on Co(1) and Co(2) sites are approximately 2.8 μ_B and 2.4 μ_B, respectively.</p>

2. 実験方法及び結果(つづき) Experimental method and results (continued)

Next, the magnetic structure was investigated at 4 K. A magnetic field of 1 T was applied in the [110] by using a superconducting magnet. The intensity data were collected and analyzed. Here we assumed that there were only two magnetic domains, because the magnetization measurement suggests spin-flop at around 0.2 T. The result indicates that the ordered spin moments on Co(2) sites, which form the honeycomb network by sharing octahedron edges, are reduced to $1.5 \mu_B$ in the magnetic field. The change may explain the nonlinear magneto-electric effect.

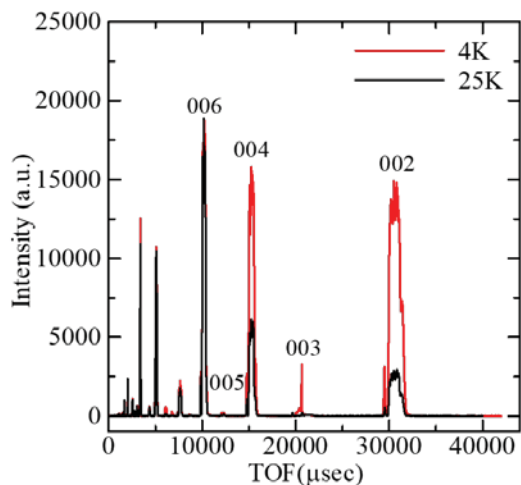


Fig. 1: Time-of-flight profiles along (00L) in zero magnetic field at 4K and 25K.

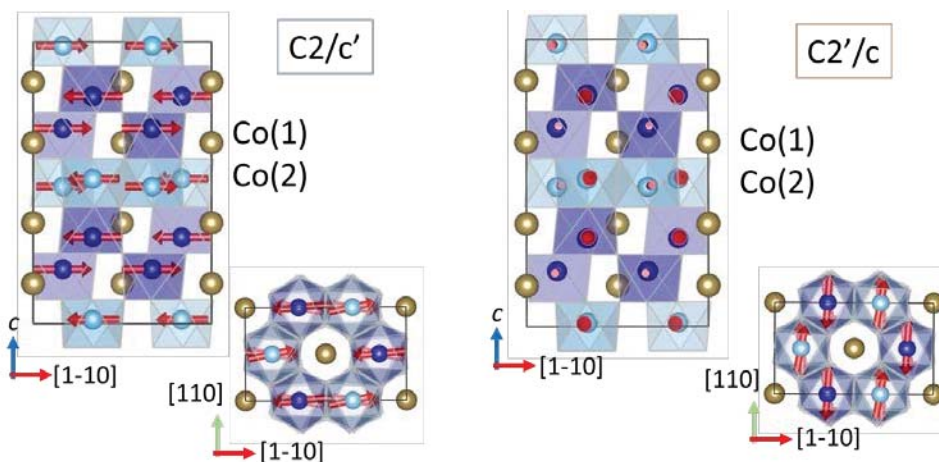


Fig. 2: Possible magnetic structures in zero field. (Left) $C2/c'$. (Right) $C2'/c$.